Supporting Information

Acid-stable magnetic core-shell nanoparticles for the separation of rare earths

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1. Vibrating Sample Magnetometry (VSM) measurements

The magnetization versus applied magnetic field loop (Figure S 1) was obtained by Vibrating Sample Magnetometry (VSM) measurements (300 K). The magnetic nanoparticles that were used as seeds for the core-shell nanoparticles were Fe_3O_4 nanoparticles coated with *n*-octylamine (NOA). These nanoparticles had a saturation magnetization of 66 emu/g and negligible coercivity and remanent magnetization, indicating superparamagnetic behavior.

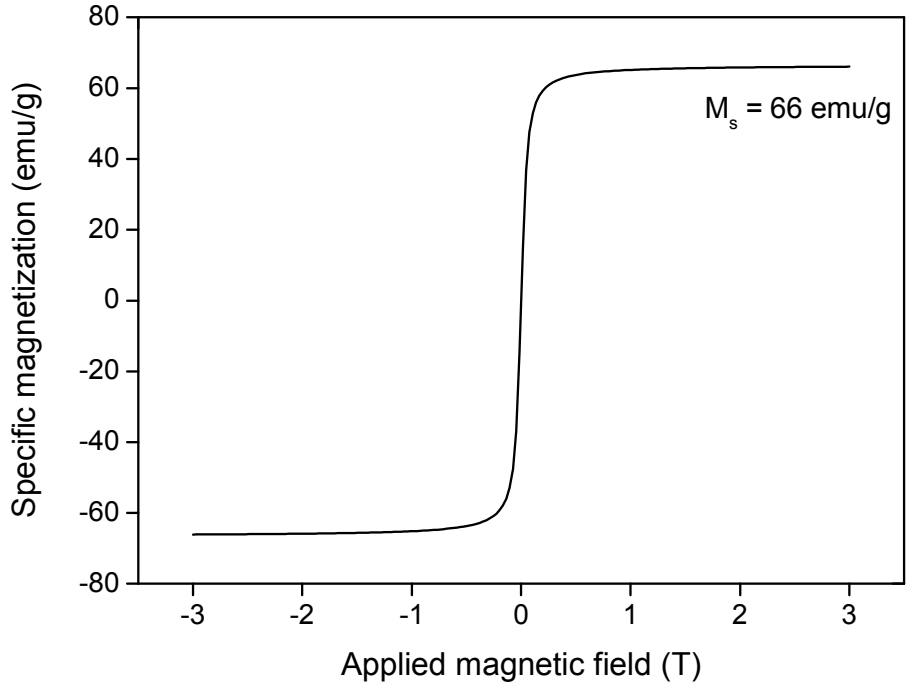

Figure S 1. VSM measurement for Fe_3O_4(NOA) nanoparticles.

2. Thermogravimetric analysis (TGA)

Thermogravimetric (TGA) analysis was used to determine the amount of TMS-EDTA on the surface of the core-shell nanoparticles (Figure S 2). The TGA measurements were done on a TA instruments Q600 thermogravimeter, measuring from 25 °C to 1200 °C at a rate of 10 °C per minute under argon atmosphere. The TGA curves in Figure S 2 show that the core-shell nanoparticles contain around 3.0 wt% of TMS-EDTA on their surface. This result is consistent with the TMS-EDTA content determined by CHN analysis.

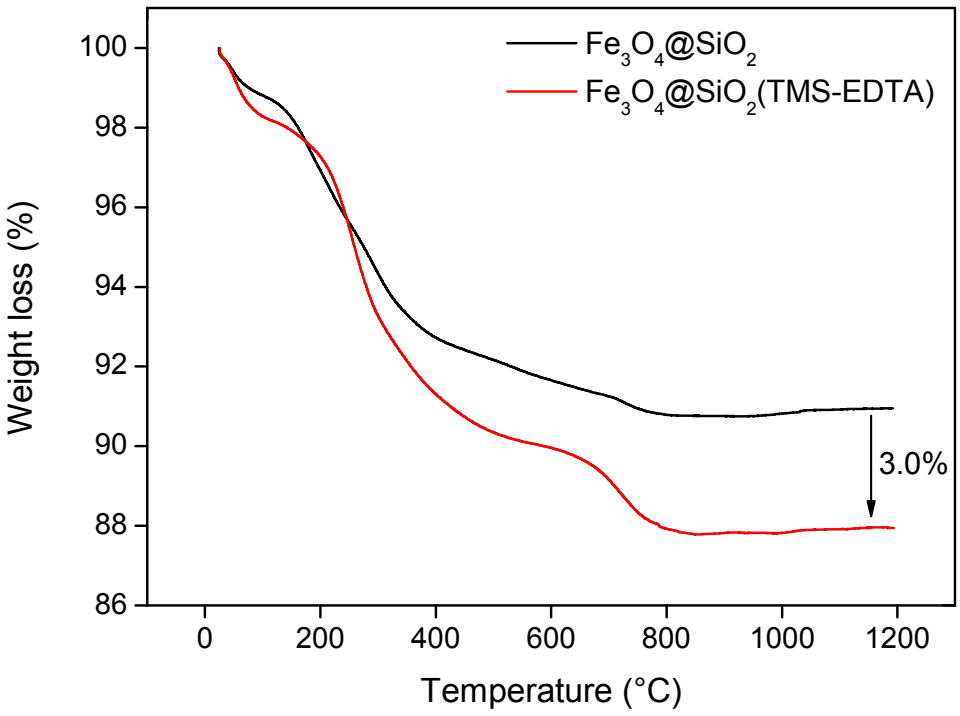

Figure S 2. TGA curves (10°C/min under argon) of the core-shell nanoparticles before and after functionalization with TMS-EDTA.

3. Fourier transform infrared spectroscopy (FTIR)

Infrared spectroscopy was used to confirm the successful coating of the Fe_3O_4 core with a SiO_2 shell (Figure S 3). The functionalization of these core-shell nanoparticles with TMS-EDTA was also confirmed using the infrared spectrum (Figure S 4). The spectra were measured between 4000 and 400 cm^{-1} on a Bruker Vertex 70 spectrometer, with a Platinum ATR module. However, only the interesting part between 2500 and 500 cm^{-1} is shown here since this range contains all the important signals.

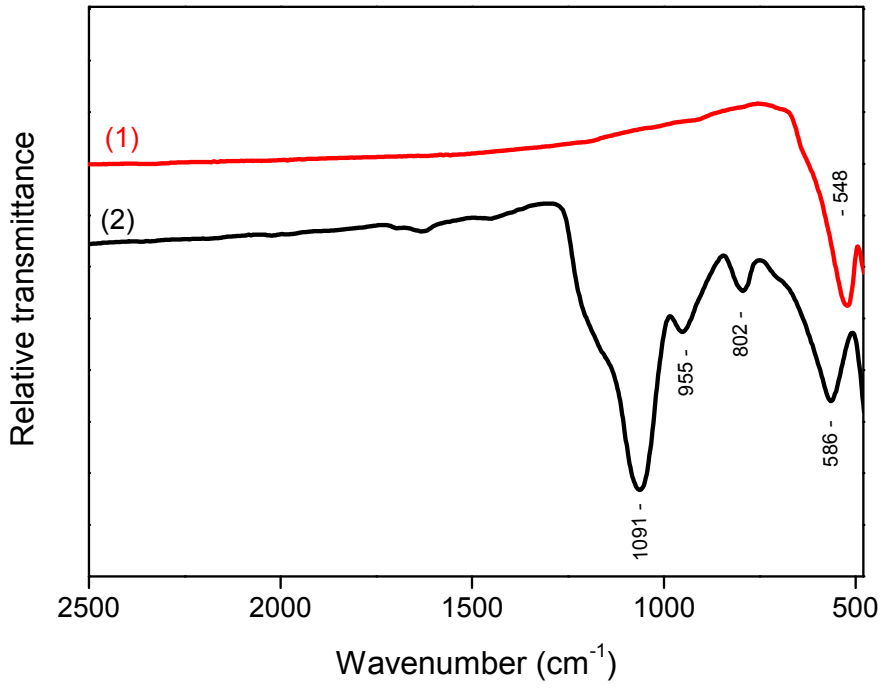

Figure S 3. Infrared spectrum of Fe_3O_4 (1) and Fe_3O_4@SiO_2 (2) nanoparticles.

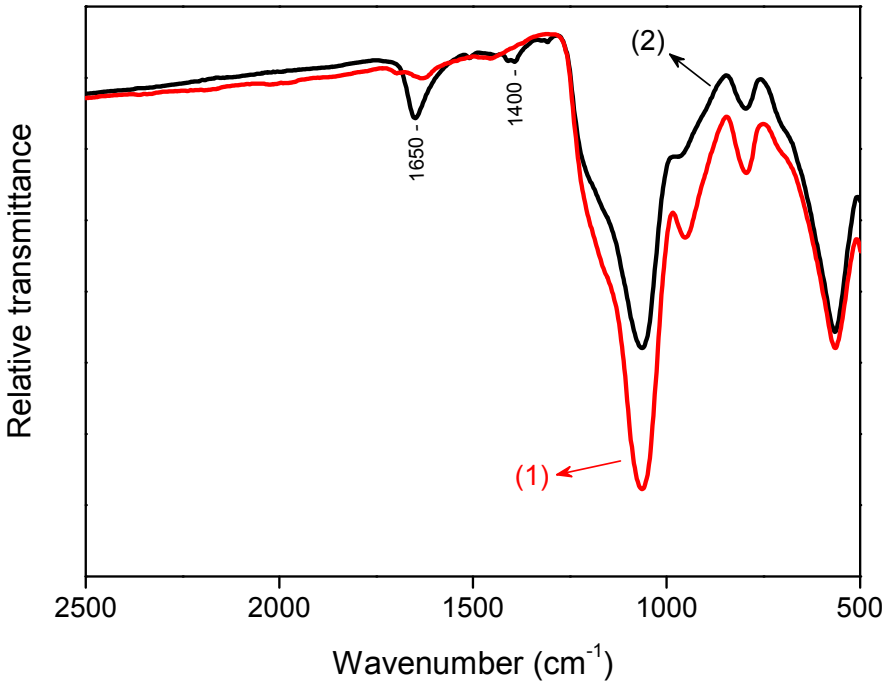

Figure S 4. Infrared spectrum of Fe_3O_4@SiO_2 (1) and Fe_3O_4@SiO_2(TMS-EDTA) (2) nanoparticles.

The appearance of the prominent peak at 1091 cm^{-1} confirms the presence of SiO_2 on the surface of the Fe_3O_4 nanoparticle (Figure S 3). The peaks at 1650 and 1400 cm^{-1} indicate the presence of carboxylate groups coming from the successful functionalization of the nanoparticles with TMS-EDTA groups (Figure S 4).